THE ODISSEY OF SMALL TELESCOPES

Antonio BIANCHINI

Department of Physics and Astronomy, University of Padova, Via Marzolo, 8, 35131 - Padova - Italy
(e-mail: antonio.bianchini@unipd.it)

Abstract. We show that the development of modern technology applied to small-sized telescopes and the choice of adequate observational programs could re-qualify their role and importance up to the point that they might even become competitive with the largest telescopes.

1. Introduction

The universe is not an 'optional' in our lives and astronomy is a powerful tool for developing human capacity all levels. The key instrument of nearly all modern observational astronomy is the telescope. Since its invention 400 years ago, the astronomical telescope has evolved from a small, manually pointed device for visual observations to a large, sophisticated, computer-controlled instrument. The recent steep increase of available information in astronomy is based on the great progress in technology, including digital imaging (direct or spectroscopic) and the ways of processing, storing, and accessing information. Modern ground-based and onboard space vehicles telescopes can analyze celestial bodies almost in any wavelength range. The success of modern astrophysics demonstrates the close interdependence of theory, observation, and experiment. Sometimes theory provides the paradigms within which observations should be planned and it is then crucial in designing new instruments.

We all know that moderate-sized telescopes have always contributed a substantial fraction of the important scientific results in astronomy. We should even remind that some of the significant discoveries obtained with large telescopes could have been made even with smaller telescopes. Today, most small-sized telescopes are equipped with instruments that contain digital imaging arrays and the scientific measurements and data obtained are generated in a digital form. Although limited in their capacity of detecting faint objects, most small telescopes can still give an important contribution to the modern astronomical research. Like for large telescopes, the observational programs can be planned to address some precise scientific problem. Djorgowski (2000) suggested that the correct observational strategy for any telescope must **recognize** '*the portion of the observable parameter space, whose axes include the area coverage, wavelength coverage, limiting flux, etc., and with a limited resolution in angular scales, wavelength, temporal baseline, etc. Each one represents a partial projection of the observable universe, limited by the observational or survey parameters (e.g., pixel sampling, beam size, filters, etc.). Every astronomical data set samples only a small portion of this grand observable parameter space, usually covering only some of the axes and only with a limited dynamical range along each axis. Every survey is also subject to its own selection and measurement limits.*'

Djorgowski concludes that Surveys represent hyper-volumes in the observable parameter space while Individual Sources represent data points (or vectors) in this multidimensional parameter space. Moreover, e says that '*federating multiple surveys that sample different portions of the observable parameter space can provide a much more complex and complete view of the physical universe.*'

Actually, all these considerations can be applied to both large and small telescopes**.**

The planet Astronomy in the world shows that the number of non-institutional, generally small-sized, private telescopes is extremely larger than the number of institutional observatories (Heck, 2000). We should also recall that most academic institutions possess both large and small telescopes. Thus all these 'minor' instruments may represent a powerful tool for astronomical research if observational programs are adequately chosen.

2. The Scientific Productivity of Smaller Telescopes

Wm. Bruce Weaver (2003) discussed in details the science effectiveness of small telescopes. He surprisingly found that the number of papers per year produced by large and small telescopes is essentially the same. However, this result will not survive if the instrumentation and maintenance of small telescopes starts being systematically neglected. The question then is: '*if small telescopes were instrumented and maintained at a level comparable to that of large telescopes, but at the lower cost proportional to their size, how much would their already impressive productivity increase?'* (Weaver, 2003).

In Fig. 1 we compare the cost per citation of ESO telescopes, of the Italian National Telescope (TNG) and of some other smaller Italian telescopes.

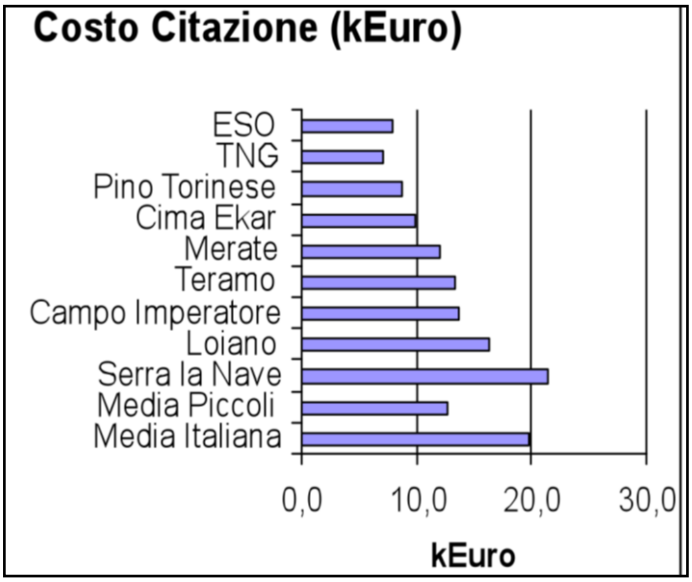

Figure 1. *COST/CITATION for ESO telescopes compared to that of some Italian observatories.*

It is evident that smaller telescopes like Pino Torinese, Cima Ekar (Asiago) still appear competitive with larger instruments. However, as we said, things may easily get worse due to a lack of upgrade of the instrumentation and of the maintenance

Concluding this reasoning we must remind that the choice of the observational programs is an important aspect of the strategy that can make a small telescope scientifically very productive.

3. The Roles of Small Telescopes in a Virtual Observatory Environment

Large digital sky surveys and archives are today becoming the principal source for many developing ideas in astronomy. In the past studies were dedicated to selected objects or relatively small samples. Now, the analysis of large uniform sky surveys is becoming more and more important. They provide more significant statistical results providing a larger number of measured attributes for each sample of sources. At the same time, this approach naturally increases the number of interesting, rare or even exotic individual targets, to be investigated in details. This way of exploring the universe leaded to the creation of the so-called Virtual Observatory (VO) astronomy. In the VO new research environment small telescopes started playing an essential role both as surveying instruments and as follow-up facilities. A very nice discussion about the new opportunities offered to small telescopes in the VO new research environment is given by Djorgovski (2000).

4. Some Added Values of Small Telescopes

Small-sized telescopes offer some trivial advantages:

1) they can be more easily used to observe targets of opportunity
2) in some cases they can be robotic and offer very fast pointing
3) they can be used as test benches for new instruments
4) they can be used for systematic long-term observations (variable stars, surveys, coordinated observations, etc.)
5) they can be used for teaching and training students
6) they may be used for outreach programs

5. A Flow-chart of the Potentialities of Small Telescopes

In Fig. 2a and b we try to schematically describe the main advantages offered by small telescopes. In Fig. 1 we distinguish between private and academic observatories. In Fig. 2a we focus our attention on what institutional observatories should do in order to qualify and re-launch the use of small telescopes. It is however obvious that private observatories might also adopt the same strategies.

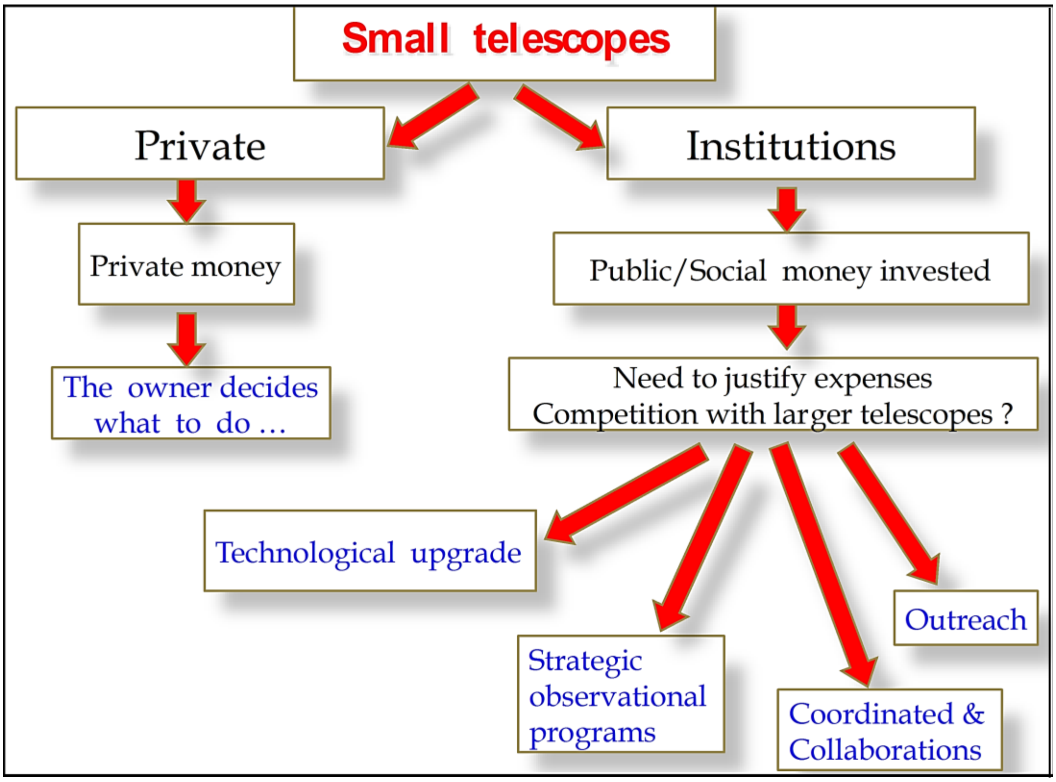

Figure 2a. *The main advantages offered by small telescopes.*

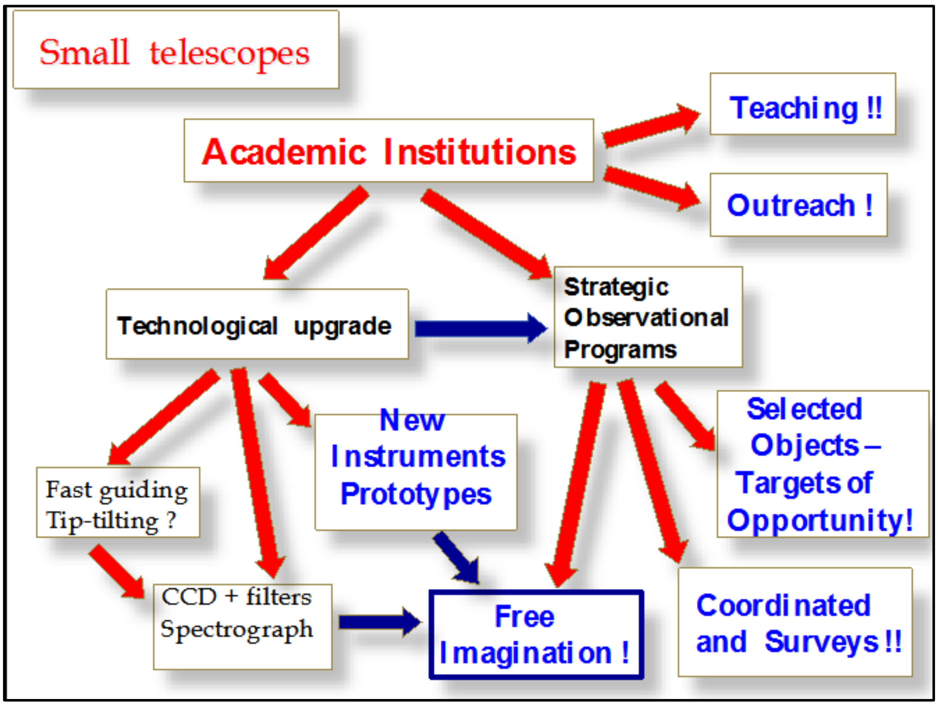

Figure 2b. *The main advantages offered by small telescopes.*

6. References

-Djorgovski, S. G., 2000, Bulletin of the AAS, Vol. 32, 1607.
-Heck, A., 2000, in 'Organizations and Strategies in Astronomy', Edited by André Heck; Kluwer Academic Publishers, Dordrecht, Volume 256, p7.
-Wm. Bruce Weaver, Wm,B., 2003, The Garrison Festschrift: held in Tucson, Arizona, Eds. R. O. Gray, C. J., Corbally,
and A. G. D. Philip. Schenectady, NY: L. Davis Press, p 87.